Polar Stratospheric Cloud Characteristics Observed During the SOLVE Campaign

Edward V. Browell1, Carolyn F. Butler, William B. Grant, Vince G. Brackett, Susan A. Kooi
NASA Langley Research Center, Hampton, VA
Owen B. Toon
University of Colorado, Boulder, CO
John Burris, Thomas McGee, Mark Schoeberl
NASA Goddard Spaceflight Center, Greenbelt, MD
M. J. Mahoney
JPL, California Institute of Technology, Pasadena, CA

Vertical profiles of multiple-wavelength aerosol backscatter and depolarization ratios and ozone mixing ratios were obtained with the NASA Langley Airborne Differential Absorption Lidar (DIAL) system along the flight-track of the NASA DC-8 during the SOLVE Campaign. Aerosol backscatter ratios were measured simultaneously at 1064 (IR), 622 (VIS), and 311 nm (UV), aerosol depolarization was measured at 1064 and 622 nm, and ozone was measured using DIAL wavelengths of 301.6 and 310.9 nm. Temperature and density profiles were obtained by the NASA Goddard AROTEL instrument, a Rayleigh and Raman lidar system operating with a fundamental laser wavelength of 355 nm, and with the JPL MTP profiler, a multi-angle microwave radiometer system.

Throughout the SOLVE campaign. polar stratospheric clouds (PSC's) were observed at cold temperatures below 195K inside the polar vortex, starting with the first local flight from Kiruna on 5 December. Evidence was also observed of the swelling of sulfate aerosols as the temperatures approached that of NAT (nitric acid trihydrate) PSC's. During the first SOLVE deployment (5-16 December), all of the PSC's were observed in the 17.5-23 km (geometric) altitude range, and they had properties of Type Ia PSC's, which included low to moderate IR and VIS scattering ratios, significant IR and VIS depolarization, and low wavelength dependence of backscattering. These properties reflect a low density of large, frozen aerosols which are inferred to be NAT. During the second SOLVE deployment (14-29 January), the temperatures were colder in the vortex, and PSC's were observed from below 14 km, which were mainly wave-driven Type II PSC's, to the highest PSC's with tops near 25 km. PSC's in the 16-25 km range were ubiquitous across most of the vortex, and outside of a few wave-driven Type II PSC's, most of the PSC's had properties of either Type Ia or Ib PSC's with distinct domains for these different populations. During the first half of the third deployment (27 February-9 March), Type Ia and Ib PSC's were found to be confined to between 12.5 to 20 km in the coldest region of the vortex, and in some cases they were in the presence of equally cold temperatures extending above them to 22 km. The reason that the NAT formation was limited to this lower altitude region is thought to be due to denitrification of the region above 20 km by earlier PSC activity.

In this paper, examples will be presented of the various types of PSC's encountered throughout SOLVE, the optical characteristics and frequency of observation of the PSC's will be summarized, and the correlation between observed PSC properties and observed temperatures from the AROTEL and MTP will be examined and compared with analyzed NCEP temperatures. DIAL ozone measurements across the vortex will also be discussed in relation to the observed PSC's and background aerosol distribution.